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Title: Battery Handling Plan

1 PURPOSE

The Battery Handling document provides procedures for handling and operating different chemistry batteries used on the GSFC missions. This document also defines the criteria for determining when to perform these procedures.

2 REFERENCE

- F. E. Ford et al., "Handbook for Handling and Storage of Nickel-Cadmium Batteries: Lessons Learned," NASA Reference Publication 1326, February 1994.
- W. R. Scott and D. W. Rusta, "Sealed-Cell Nickel-Cadmium Battery Applications Manual," NASA Reference Publication 1052, December 1979.
- D. Sullivan, "Tropical Rainfall Measuring Mission Super NiCd Battery Handling Plan," TRMM-734-371, May 1997.
- S. Tiller, "X-Ray Timing Explorer (XTE) Super NiCd Battery Handling Plan," XTE-LSOP-PLAN-001, February 1995.
- T. Yi, "Cosmic Background Explorer Battery Handling Plan," COBE-PL-711-1113-1101-01D, August 1989.
- S. Tiller, "SAMPEX Battery Handling Plan for 9Ah Super Nickel Cadmium Battery," SAMPEX-PROC-0018, March 1990.
- S. Tiller, "FAST Super NiCd Battery Handling Plan," FAST-PROC-0004, October 1992.
- S. Tiller, "SWAS Super NiCd Battery Handling Plan," SWAS-MGMT-0030, December 1993.
- D. Sullivan, "TRACE Super NiCd Battery Handling Plan," TRACE-MGMT-0026, December 1997.
- D. Linden. "Handbook of Batteries and Fuel Cells," McGraw-Hill Book Co., 1984.

- J. B. Trout, "Manned Space Vehicle Battery Safety Handbook," JSC-20793, September 1985.
- J. D. Dunlop et al., "NASA Handbook for Nickel-Hydrogen Batteries," NASA Reference Publication 1314, September 1993.
- G. Halpert et al., "The NASA Aerospace Battery Safety Handbook," JPL Publication 86-14, July 1986.
- B. Bragg et al., "Primary Battery Design and Safety Guideline Handbook," NASA Reference Publication, December 1994.

A. Himy, "Silver Zinc Battery: Phenomena and Design Principles," Vintage Press, 1986.

3 SCOPE

The procedures and criteria in the Battery Handling Document are formulated to minimize degradation of the batteries during pre-flight storage, handling, and testing. Implementation of these procedures will assure optimum condition of the batteries at launch and the optimum performance throughout the GSFC mission.

The guidelines and procedures in this document will be based on the experience gained in other flight programs and controlled tests.

4 **DEFINITIONS**

Ampere Hours The total quantity of electricity [integration of current (ampere) and

time (hours)] during the discharge or charge stpes.

Battery Two or more cells connected in series, parallel, or a combination of

both, or a single cell used as a single-cell battery.

Capacity Total charge (ampere hours of stored energy) in a single cell/battery

Cell An electrochemical device consisting of an anode and a cathode in a

common electrolyte, or in separate electrolytes connected by an

ionic bridge.

Charge The process of storing electrical energy in a secondary

(rechargeable) battery by forcing current to flow through the cell/battery which restores discharged material to its charged state.

Discharge The process of obtaining electric power from a battery by

connecting a load across the battery terminals, allowing the voltage

of the battery to force current through the load.

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http://gdms.gsfc.nasa.gov/gdms to verify that this is the correct version prior to use.

Overcharge Continued charge of the cell after it has been fully charged.

Overdischarge Forcing current through the cell in the discharge direction after

useable energy has been exhausted.

Self Discharge The spontaneous discharge while standing a charged cell/battery on

open circuit without load.

Trickle Charge A low-level constant current charging used to maintain the battery

at the fully charged level, countering the self-discharge, with a

minimum damage due to overcharging.

5 AUTHORITIES AND RESPONSIBILITIES

The Senior Battery Engineer has the overall responsibility of the battery. He provides the top level guidelines to Battery Engineer, Battery Test Engineer, and Battery Technician, in developing the Battery Handling Plan. The Battery Engineer has the technical responsibility of the battery, from fabrication, assembly, delivery, and the preparation of the Battery Handling Plan. The Battery Test Engineer and Battery Technician have the responsibility of integration and testing of the batteries, with assistance from the Battery Engineer.

6 IMPLEMENTATION

The Senior Battery Engineer, with assistance from the Battery Engineer, Battery Test Engineer and Battery Technician, will provide top level guidelines to be used in the Battery Handling Plan. The Battery Engineer who has the responsibility in completing the Plan will address the following, where applicable, in the Battery Handling Plan:

6.1 Safety Considerations

These items, where applicable, address the safety of the personnel working with the batteries:

- 6.1.1 Lifting and Supporting Batteries
- 6.1.2 High Current Hazard
- 6.1.3 Jewelry and Tool Hazard
- 6.1.4 Connector Mating and Demating
- 6.1.5 Spacecraft and GSE Battery Connections

6.2 General Requirements

These items, where applicable, address equipment and materials required for conducting the operations defined in the Battery Handling Plan:

6.2.1 Equipment: Connector Savers, Battery Cover, Battery Baseplate, GSE, Cooling Carts, Letdown Box, Air Conditioning Equipment

- 6.2.2 Materials: Thermal Conductive Material, Phenolphthalein Solution, Reagent Grade Acetone, , Reagent Grade Alcohol, Lint-free Tissue
- 6.3 Test & Storage Environment

These items, where applicable, address specific environmental conditions, test regimes, battery storage and shipping requirements associated with conducting the operations defined in the Battery Handling Plan:

- 6.3.1 Test Control
- 6.3.2 Temperature Requirements
- 6.3.3 Battery Storage Requirements
- 6.3.4 Battery Maintenance Requirements
- 6.3.5 Battery Shipping Requirements
- 6.3.6 I&T/Ground Operating Limits

6.4 Battery Laboratory Activities

These activities, where applicable, are performed on the batteries from the time they are delivered to the Power Systems Branch until they are ready for installation in the spacecraft:

- 6.4.1 Battery Acceptance Test
- 6.4.2 Battery Recharge
- 6.4.3 Battery Trickle Charge
- 6.4.4 Battery Cold Storage
- 6.4.5 Battery Reconditioning
- 6.4.6 Battery Discharge
- 6.4.7 Battery Top-Off Charge

6.5 Battery-to-Spacecraft Integration Activities

These activities, where applicable, are performed on the batteries from the time they have finished the Battery Laboratory Activities until they are ready for Spacecraft System Test and Checkout Activities:

- 6.5.1 Battery Reconditioning
- 6.5.2 Battery Recharge
- 6.5.3 Battery Discharge
- 6.5.4 Battery Top-Off Charge

6.6 Spacecraft System Test and Checkout Activities

These activities, where applicable, are performed on the batteries from the time they have finished the Battery Spacecraft Integration Activities until they are ready for Spacecraft Pre-Ship Activities:

- 6.6.1 Battery Reconditioning
- 6.6.2 Battery Recharge
- 6.6.3 Battery Discharge

- 6.6.4 Battery Top-Off Charge
- 6.6.5 Battery Trickle Charge
- 6.7 Spacecraft Launch Site Activities

These activities, where applicable, are performed on the batteries from the time they have finished the Spacecraft System Test and Checkout Activities until they are ready for Launch:

- 6.7.1 Battery Reconditioning
- 6.7.2 Battery Recharge
- 6.7.3 Battery Discharge
- 6.7.4 Battery Top-Off Charge
- 6.7.5 Battery Trickle Charge

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	10/02/1998	Initial Release